

1. A method of determining range of a radar target comprising:  
receiving signal samples based on returns of a target during tracking;  
processing the signal samples to produce a wideband envelope range estimate for  
components of target motion comprising precession and spin motion components;  
5 measuring the signal samples to produce ambiguous phase values; and  
using each wideband envelope range estimate and ambiguous phase value to produce an  
unambiguous phase value indicative of range.
2. The method of claim 1, further comprising:  
10 determining an estimate of ballistic trajectory for the signal samples; and  
removing the estimated ballistic trajectory during processing.
3. The method of claim 1 wherein processing operates at a sampling rate that is at least  
twice the frequency of the spin motion components.
- 15 4. The method of claim 2 wherein using comprises:  
subtracting the measured ambiguous phase from the wideband envelope range estimate  
to produce an error value associated with the wideband envelope range estimate; and  
subtracting the error value from the wideband envelope range estimate to give the  
20 unambiguous phase value.
5. The method of claim 4 further comprising:  
determining a magnitude of the error value and  
adjusting resources of a radar system that performs the tracking to ensure that the  
25 magnitude of the error is less than a one sigma error.
6. The method of claim 5 wherein the radar system resources comprise signal-to-noise ratio.
7. The method of claim 6 wherein the radar system resources further comprise data rate.
- 30 8. The method of claim 4 wherein processing comprises:  
producing a spectrum of wideband envelope range estimates from the signal samples;

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transforming the wideband envelope range estimates to obtain a spectral estimate of each motion component of precession, spin, spin plus precession and spin minus precession;  
detecting each motion component;  
estimating amplitude, frequency and phase for each motion component spectral estimate;  
5 and  
forming a sinusoid in range motion from the estimate of amplitude, frequency and phase for each motion component spectral estimate.

9 ~~7~~. The method of claim 6 wherein processing occurs in batch mode for signal samples  
10 obtained during several cycles of precession motion.

10 ~~8~~. The method of claim 6 wherein the signal samples comprise pulses and using further  
comprises:  
using the sinusoid in range motion to determine an integer number  $k$  of cycles in phase  
15 change between the pulses.

11 ~~9~~. The method of claim 8 wherein using further comprising adding  $2\pi k$  to the measured  
ambiguous phase value prior to subtracting the measured ambiguous phase value from the  
wideband envelope range estimate.

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12 ~~10~~. An apparatus for determining range of a radar target comprising:  
a stored computer program in memory instituting the steps of  
processing the signal samples based on returns of a target during tracking to produce a  
wideband envelope range estimate for components of target motion comprising precession and  
25 spin motion components;  
measuring the signal samples to produce ambiguous phase values; and  
using each wideband envelope range estimate and ambiguous phase value to produce an  
unambiguous phase value indicative of range.

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30 ~~11~~. An apparatus for determining range of a radar target comprising comprising:

means for processing the signal samples based on returns of a target during tracking to produce a wideband envelope range estimate for components of target motion comprising precession and spin motion components;

means for measuring the signal samples to produce ambiguous phase values; and

5 means for using each wideband envelope range estimate and ambiguous phase value to produce an unambiguous phase value indicative of range.

14 ~~12.~~ A system comprising:

a transmitter/receiver to direct transmit signals to and receive return signals from a target;

10 a processor to process the return signals as in-phase and quadrature samples to produce angle information and range signals;

a tracker to track a target detected according to results of the processing by the first processor, the tracker measuring range data during tracking and estimating a ballistic trajectory therefrom; and

15 a unit operable to use a wideband envelope range estimate of the in-phase and quadrature samples, the ballistic trajectory estimate and an ambiguous phase measurement of the in-phase and quadrature samples to produce a range measurement that is unambiguous in phase.